

HARFORD COUNTY GOVERNMENT

DEPARTMENT OF PUBLIC WORKS

DIVISION OF HIGHWAYS & WATER RESOURCES



Excerpts from the Maryland Dam Safety Manual

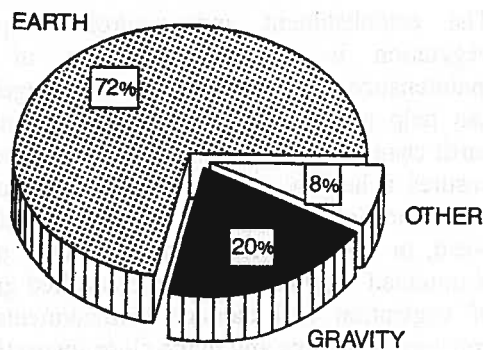
Stormwater Management Maintenance & Repair

**1996 Edition
Revised November, 2003**

COMMON DAM ELEMENTS

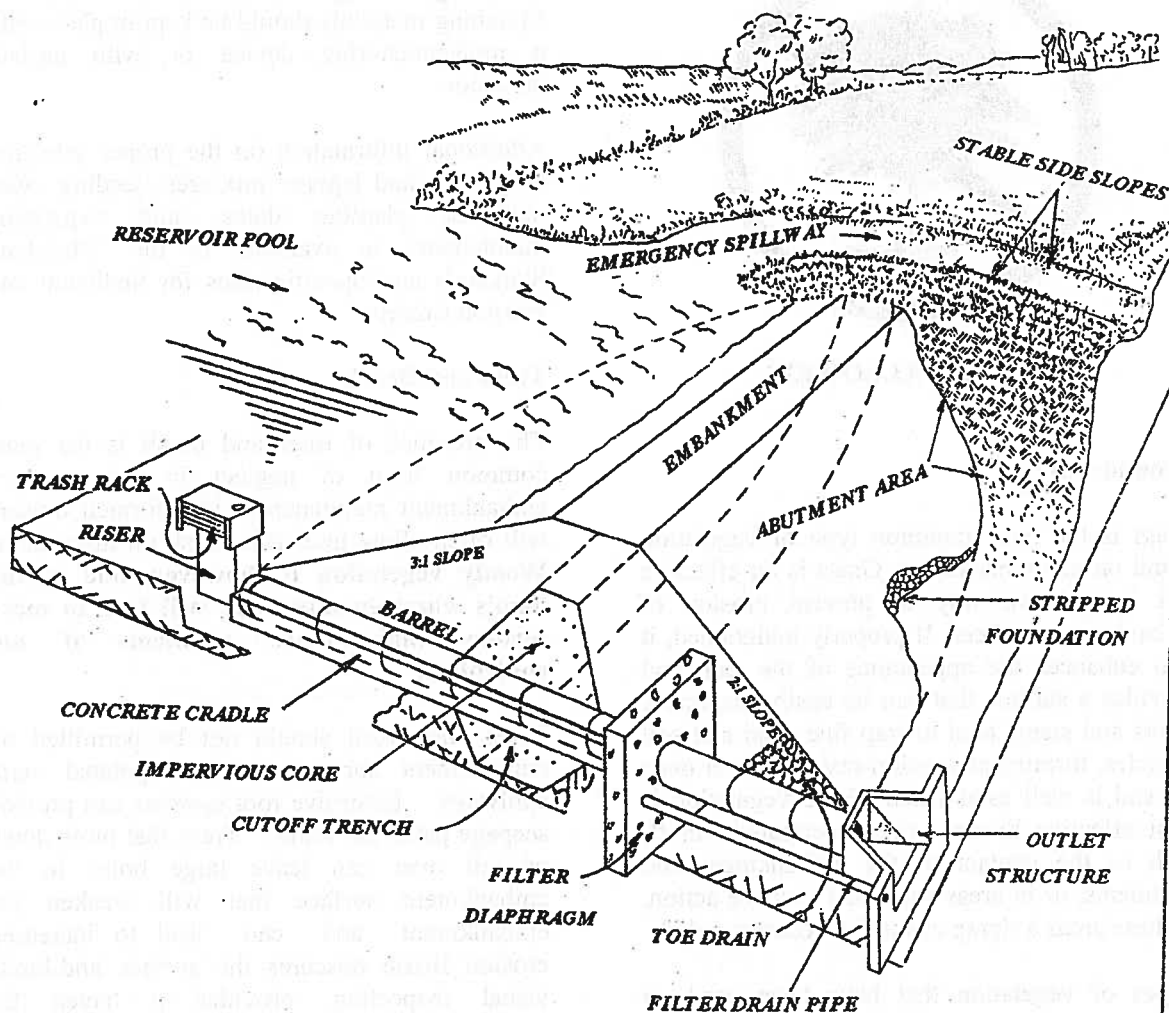
Dams can be constructed of various materials such as concrete, earth, rock, and wood. Many of the common dam types are listed in the glossary. In Maryland, the different types of dams are listed in the adjacent chart:

As one can see, the majority of dams are constructed of earth. Therefore, the primary focus of this manual will be toward this type of dam. The figure below illustrates the common elements of an earthen dam.



**Maryland Dams
By Type**

PRINCIPAL FEATURES of an EARTH DAM



VEGETATION

The establishment and control of proper vegetation is an important part of dam maintenance. Properly maintained vegetation can help prevent erosion of embankment and earth channel surfaces. Proper maintenance also ensures a healthy stand of vegetation that can withstand extreme climatic conditions and pest, weed, or disease infestation better than poorly maintained vegetation. The uncontrolled growth of vegetation will damage embankments and concrete structures and make close inspection of the dam difficult. Aesthetics, unobstructed viewing during inspections, maintenance of a nonerodible surface, and discouragement of burrowing animal habitation are reasons for proper maintenance of the vegetative cover.



NO TREES ALLOWED!

Ground Covers

Grass is the most common type of vegetation found on an embankment. Grass is an effective and inexpensive way to prevent erosion of embankment surfaces. If properly maintained, it also enhances the appearance of the dam and provides a surface that can be easily inspected. Roots and stems tend to trap fine sand and soil particles, forming an erosion-resistant layer once the sod is well established. Grass vegetation is least effective in areas of concentrated runoff, such as the contact of the embankment and abutments, or in areas subjected to wave action. In these areas a riprap channel is recommended.

Types of vegetation that have been used on

dams in Maryland are tall fescue, red fescue, clover, redbud, and sericea lespedeza. Deep rooted grasses should be planted in vegetated earth spillways. One hundred percent Kentucky 31 Fescue is excellent for erosion protection. Seeding should be accomplished between optimum planting dates. Seeding late in the year may result in winterkill of young seedlings. The following spring an inspection of the seeded area should be made to determine if plant survival is satisfactory.

Before seeding, fertilizer and lime should be applied. Exact quantities necessary will vary with soil type and condition, and can be determined by having the soil tested. The fertilizer and lime should be raked, disced, or harrowed into the soil to a depth of not less than 4 inches. Periodic fertilization is necessary to maintain vigorous vegetation. Immediately following seeding, the area should be mulched. Mulching materials should be kept in place with a mulchanchoring device or with asphalt emulsion.

Additional information on the proper selection of grasses and legume mixtures, seeding rates, optimum planting dates, and vegetation maintenance is available in the "Maryland Standards and Specifications for Sediment and Erosion Control."

Trees and Brush

The presence of trees and brush is the most common form of neglect in the area of embankment maintenance. Uninformed owners will often allow trees and brush on their dams. **Woody vegetation is, however, one of the dam's worst enemies, and will lead to more serious maintenance problems if not controlled.**

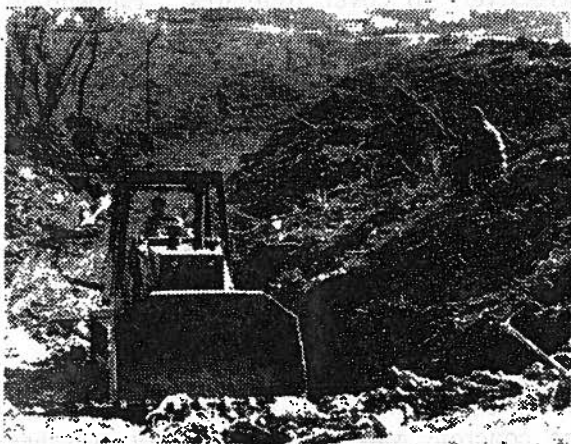
Trees and brush should not be permitted on embankment surfaces or in vegetated earth spillways. Extensive root systems can provide seepage paths for water. Trees that blow down or fall over can leave large holes in the embankment surface that will weaken the embankment and can lead to increased erosion. Brush obscures the surface and limits visual inspection, provides a haven for

inspection, provides a haven for burrowing animals, and retards growth of grass vegetation. Tree and brush growth adjacent to concrete walls and structures may eventually cause damage and should be removed.



Failure Due to Root System

Trees that have been allowed to grow on the dam should be removed so desirable vegetation can be established and the surface can be mowed. The stumps can be removed either by pulling or with machines that grind them down. For trees greater than eight inches in diameter, all woody material should be removed to about 24 inches below the ground surface. The cavity should be filled with well compacted soil and grass vegetation established.



Tree/Stump Removal

Stumps less than eight inches in diameter may be left in place if cut flush with the ground and treated with a silvicide.

Stumps of trees in riprap cannot easily be removed, but should be chemically treated so they will not continually form new sprouts. The removal of large trees and stumps is expensive and usually requires the use of heavy construction equipment.

Mowing and Brush Removal

Embankments, areas adjacent to spillway structures, vegetated channels, and other areas associated with a dam require periodic maintenance of the vegetative cover. Grass mowing, brush cutting, and removal of woody vegetation (including trees) is necessary for the proper maintenance of a dam. All embankment slopes and vegetated earth spillways should be mowed or trimmed at least once a year. Brush removal is also important beyond the downstream toe of the dam in order to allow inspection for "boils" (see Seepage).

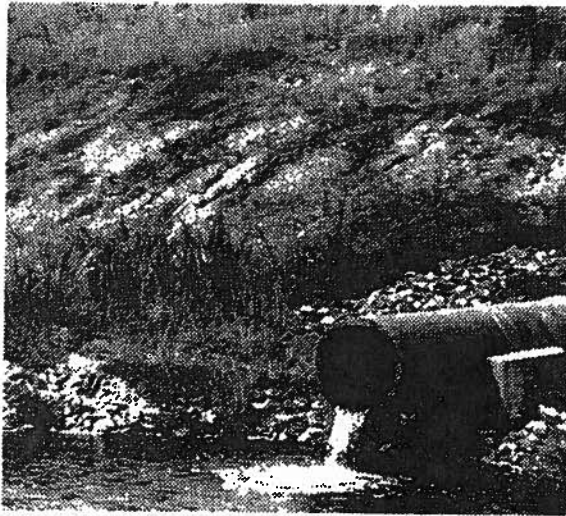
Methods used in the past for control of vegetation that now may be considered unacceptable include chemical spraying and burning. More acceptable methods include the use of weed whips, power brush-cutters and mowers. It is important to remember to use the proper equipment for the slope and type of vegetation to be cut, and to always follow the manufacturer's recommended safe operation procedures.



Mowing Embankment With Special Equipment

EROSION

Whether on a slope or at a spillway outlet, erosion is a common maintenance problem on the embankment structure. Erosion is a natural process and its continuous forces will eventually wear down almost any surface. The rate of erosion is directly related to the lack of vegetation. Periodic and timely maintenance is essential in preventing continuous deterioration, more costly repairs at a later date, and possible failure of the dam.



Embankment Erosion

Vegetated Surfaces

A sturdy sod, free of weeds and brush, is one of the most effective means of erosion protection. Embankment slopes are normally designed and constructed so that the surface drainage will be spread out in thin layers as "sheet flow" on the grassy cover. When the sod is in poor condition or flows are concentrated at one or more locations, the resulting erosion will leave rills and gullies in the embankment slope. The owner should look for these areas and be aware of the problems that may develop.

Prompt repair of eroded areas is required to prevent more serious damage to the embankment. Rills and gullies should be filled with suitable soil (the upper 4 inches should be topsoil, if available), compacted, and then seeded. Methods described in the section on vegetation should be used to properly

establish the grassed surface. Erosion in large gullies can be slowed by stacking bales of hay or straw across the gully until permanent repairs can be made.



Erosion Left Unattended

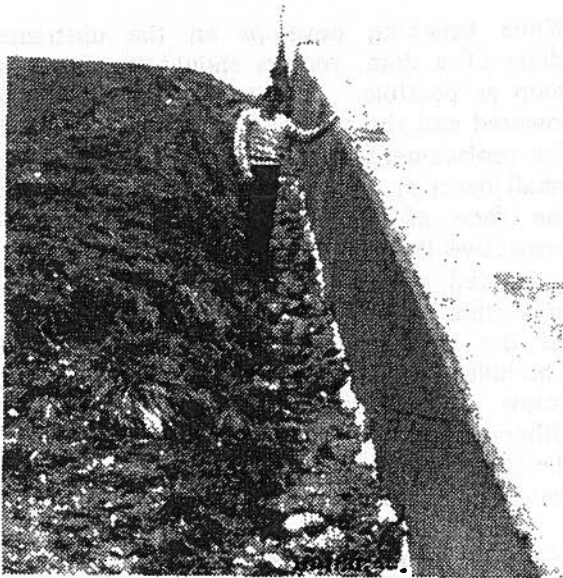
Repairs of the eroded areas should also address the cause of the erosion in order to prevent a continuing maintenance problem. Erosion may be aggravated by improper drainage, settlement, pedestrian traffic, animal burrows, or other factors. The cause of the erosion will have a direct bearing on the type of repair needed.

Paths from pedestrian traffic are problems common to many embankments. If a path has become established, vegetation in this area will not provide adequate protection and more durable cover will be required unless the traffic is eliminated. Small stones, asphalt, or concrete have been used effectively to cover footpaths. Embedding railroad ties or other treated wood beams into an embankment slope to form steps is one of the most successful and inexpensive methods used to provide a protected pathway.

Worn areas also result from unwanted two and four-wheel vehicle traffic. Control of these vehicles is discussed in the section on vandalism.

Another area where erosion commonly occurs is the contact between the embankment and the concrete walls of the spillway or other structures. Poor compaction adjacent to the

wall during construction and subsequent settlement could leave an area lower than the grade of the embankment. Runoff often concentrates along these structures, resulting in erosion. Possible solutions include regrading the area to slope away from the wall, adding more resistant surface protection, or constructing wood beam steps.



Pedestrian Path Erosion

Abutment Contacts

Adequate erosion protection is required along the contact between the downstream face of the embankment and the abutments. Runoff from rainfall concentrates in these gutter areas and can reach erosive velocities because of the steep slopes. Berms on the downstream face that collect surface water and empty into these gutters add to the runoff volume. Sod gutters may not adequately prevent erosion in these areas. A well graded mixture of rock with stones that are 9 to 12 inches in diameter, or larger, placed on a stone filter or filter fabric provides the best protection on small dams.

Paved concrete gutters do not hold up well, will not slow the velocity of the water, can become undermined, and therefore are not recommended. Groundhogs often construct burrows underneath these gutters, possibly since burrowing is easier due to existing undermining.

Erosion adjacent to gutters results from improper construction or design where the finished flow line of the gutter is too high with respect to adjacent ground. This condition prevents all or much of the runoff water from entering the gutter. The flow concentrates alongside the gutter, erodes a gully, and may eventually undermine the gutter.

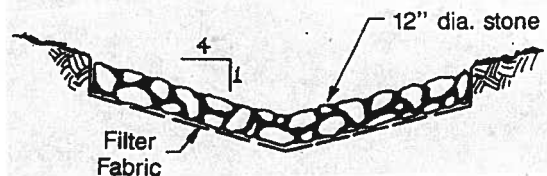


Care should be taken when replacing failed gutters or designing new gutters to assure that:

1. The channel has adequate capacity,
2. Adequate protection and a satisfactory filter have been provided,
3. Surface runoff can enter the gutter, and
4. The outlet is adequately protected from erosion.



Riprap Gutter Construction



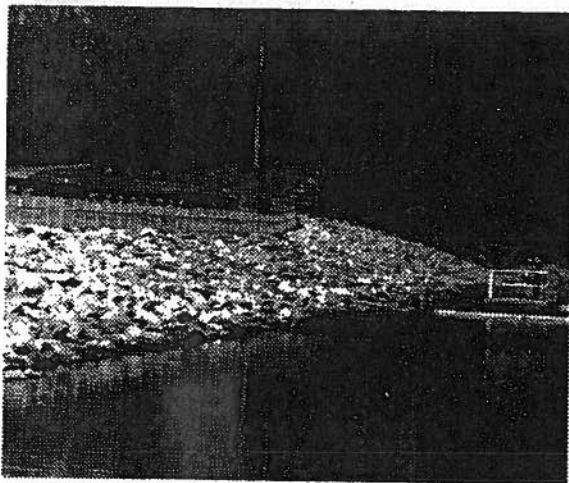
Riprap Ditch Detail

SLOPE PROTECTION

The upstream face of a dam is commonly protected against wave erosion by placement of a layer of rock riprap over a layer of filter material. This provides a surface on which the wave energy can dissipate.

Riprap should consist of a heterogeneous mixture of irregular shapes placed over a filter material. The maximum rock size and weight must be large enough to break up the energy of the anticipated wave action and hold the smaller stones in place. Generally, the largest stones should be at least 12 inches in diameter. The smaller rocks help to fill the spaces (or voids) between the rocks in the riprap. If the filter material can be washed out through these voids two filter layers will be required. The lower layer should be composed of sand or filter fabric to protect the soil surface. The second layer should be composed of coarser materials that prevent washout through the voids in the riprap.

A dam owner should expect some deterioration (weathering) of riprap. Freezing and thawing, wetting and drying, abrasive wave action, and other natural processes will eventually break down the riprap. The useful life of riprap varies with the characteristics of the stone used. Stone for riprap should be rock that is dense and well cemented.

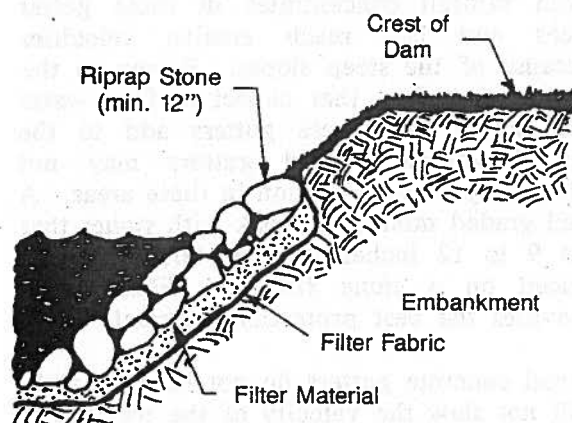


Properly Installed Protection

Another erosion problem which can develop on the upstream slope of the dam is "beaching." Waves caused by winds or power boats can erode the exposed face of the embankment. This action displaces the soil material farther down the slope, creating a "beach". Effective slope protection must prevent the soil particles from being removed from the embankment.

When beaching develops on the upstream slope of a dam, repairs should be made as soon as possible. The pool level should be lowered and the surface of the dam prepared for replacement of the slope protection. A small berm or "bench" should be made across the face of the dam to help hold the protective layer in place. The bench should be placed at the base of the new layer of protection. Depth of the bench will depend on the thickness of the protective layer. The layer should extend a minimum of 3 feet below the lowest anticipated pool level. Otherwise, wave action during periods when the lake level is drawn down can undermine and destroy the protective layer.

Sufficient maintenance funds should be allocated for the regular replacement of riprap. When riprap breaks down, erosion and beaching will occur more often than once every three to five years, professional advice should be sought to design more effective slope protection.

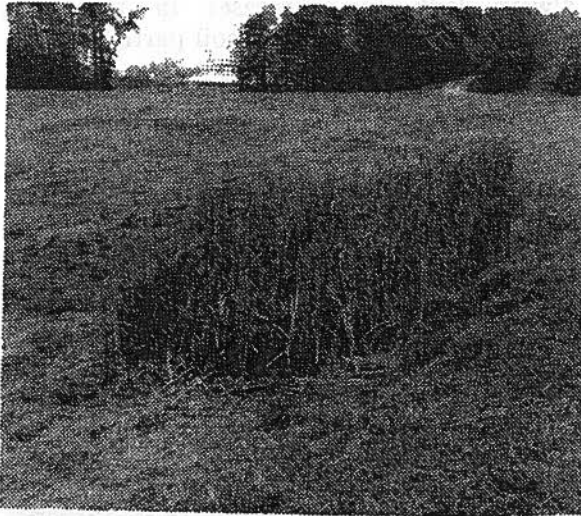


Slope Protection Detail

SEEPAGE

Contrary to popular opinion, wet areas downstream from dams are not usually natural springs but seepage areas. Even if natural springs exist in the area, they should be treated with suspicion and carefully observed. Flows from groundwater springs in existence prior to the reservoir usually increase in flow due to the pressure caused by a pool of water behind the dam.

All dams have some seepage as the impounded water seeks paths of least resistance through the dam and its foundation. However, seepage must be controlled in both velocity and quantity to minimize damage to the structure.



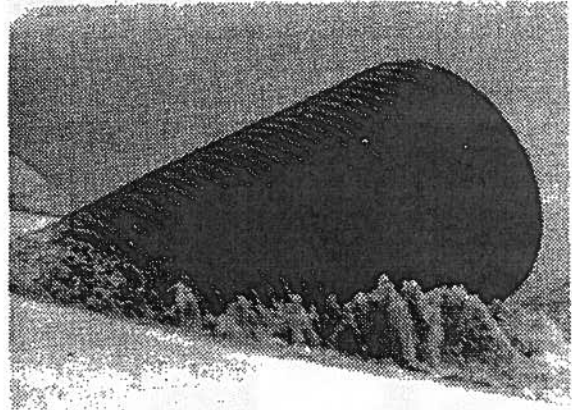
Evidence of Seepage

Detection

Seepage can emerge anywhere on the downstream face, beyond the toe, or on the downstream abutments at elevations below normal pool. Seepage may vary in appearance from a "soft," wet area to a flowing "spring." It may show up first as an area where the vegetation is more lush and darker green. Cattails, reeds, mosses, and other marsh vegetation often become established in a seepage area. In the winter, seepage areas may be evidenced by areas of ice buildup or areas of melted snow on the embankment. Downstream abutment contact areas should always be inspected closely for signs of seepage. Seepage can

also occur along the contact between the embankment and a conduit spillway, drain, or other appurtenance. Slides on the embankment may be the result of seepage causing soil saturation or pressures in the soil pores.

At most dams, some water will seep from the reservoir through the foundation. Where it is not intercepted by a subsurface drain, the seepage will emerge downstream from or at the toe of the embankment. If the seepage forces are large enough, soil will be eroded from the foundation and be deposited in the shape of a cone around the seepage outlet. If these "boils" appear, professional advice should be sought immediately. Seepage flow which is muddy and carrying soil particles is evidence of "piping," and complete failure could occur within hours.



Piping Along Spillway Conduit

Piping can occur along a spillway and other conduits through the embankment, and these areas should be closely inspected. Sinkholes that develop on the embankment are signs that piping has begun, and may soon be followed by a failure of the dam. Emergency procedures, including downstream evacuation, must be implemented if this condition is noted. (See section on Emergency Procedures.)

A continuous or sudden drop in the normal lake level may be an indication that seepage is occurring. In this case, one or more locations of flowing water are usually noted downstream from the dam. This condition in itself may not be a serious problem, but will require frequent and close monitoring and professional assistance.

Control

The need for seepage control will depend on the quantity, content, and location of seepage. Controlling the quantity of seepage that occurs after construction is difficult, quite expensive, and not usually attempted unless the seepage is endangering the embankment or appurtenant structures. Typical methods used to control the quantity of seepage are installation of an upstream blanket, or the installation of relief wells or drainage trenches and drains. All of these methods must be designed and constructed under the supervision of a professional engineer experienced with dams and require a state permit.



Toe Drain Installation

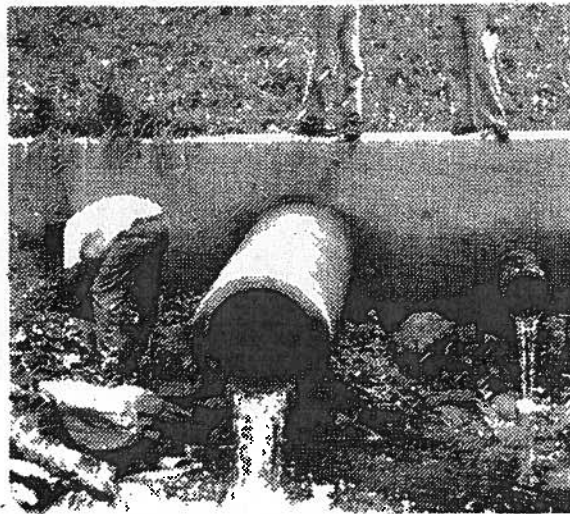
Preventing loss of soil particles by seepage is extremely important. Modern design practice incorporates this control into the embankment through the use of cutoffs, internal filters, and adequate drainage provisions. Control of seepage at the downstream toe can be accomplished by using properly graded filters and providing proper drainage. The filter and drainage system should be designed to prevent migration of soil particles and still provide for passage of the seepage flow.

The location of a seepage or wet area on the embankment or abutment is often a primary concern. Excessive seepage pressure or soil saturation can threaten the stability of the downstream slope of the dam or the

abutments. Seepage control can sometimes be accomplished by installing trench drains.

Monitoring

Regular monitoring is essential to detect seepage and prevent failure. Without knowledge of the dam's history, the owner has no idea whether the seepage condition is in a steady state (constant) or fluctuating condition. It is important to keep written records of points of seepage, quantity of flow, soil particle content, size of wet area, and type of vegetation for later comparison. The rate and content of flow emerging from these outlets should be monitored regularly and recorded. Photographs provide valuable records of seepage. The owner should always look for increases in flow and evidence of flow carrying soil particles.



Monitoring Internal Drain Seepage

Regular surveillance and maintenance of internal embankment and foundation drainage outlets is also recommended. Normal maintenance consists of removing any soil or other material that obstructs flow. Internal repair is complicated and often impractical and should not be attempted without professional advice.

STABILITY

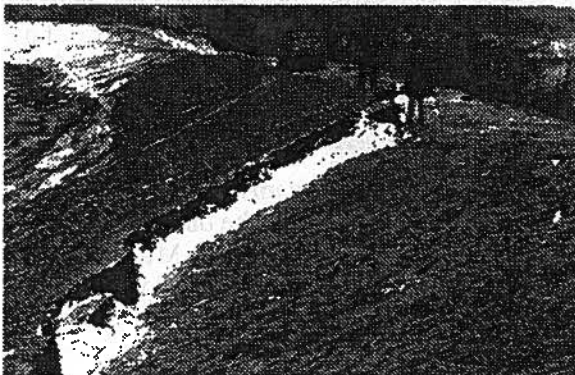
The embankment must safely contain the reservoir. Cracks, slides, sloughing, and settlement are signs of embankment distress and should indicate to the owner that maintenance or remedial work is required. The cause of the distress must be determined by an experienced engineer before undertaking repairs. This step is important because poorly conceived repairs may cause greater and more serious damage to the embankment and can cause failure of the dam.

Cracks

The entire embankment must be closely inspected for cracks. Short, isolated cracks are not usually significant, but larger well-defined cracks indicate a serious problem. There are two types of cracks that occur on the embankment surface - transverse and longitudinal.

Transverse cracks appear perpendicular to the dam axis and indicate differential settlement within the embankment. Such cracks provide avenues for seepage and the piping of embankment material could develop quickly.

Longitudinal cracks run parallel to the dam axis and may signal the early stages of a slide or slump on either face of the embankment. In recently built structures, these cracks may indicate inadequate compaction of the embankment or inadequate foundation preparation during construction.



Transverse Crack

Small cracks, as they appear, should be documented, immediately examined by a professional engineer or the Dam Safety Division, and then sealed. The seal will prevent surface water from entering the cracks and causing saturation of embankment material. Saturation could possibly trigger a slide or other serious problems.

Sealing can be accomplished by compacting clay in the cracks. After the cracks have been sealed, the areas should be monitored frequently to determine if movement is still occurring. Slides or crack locations can be documented with photographs and sketches or diagrams. Continued movement is an indication of a more serious problem such as a slide.

Slides

Slides and slumps are serious threats to the safety of a dam and can initiate catastrophic failure. The need for immediate professional assistance to determine the cause of cracks and slides and to recommend remedial action cannot be overemphasized.

Slides can be detected easily unless obscured by tall vegetation. Arc-shaped cracks are indications that a slide or slump is beginning. These cracks can develop into a large scarp in the slope at the top of the slide.



Slide Failure

If a slide develops, the reservoir should be drained. The scarp should be sealed to prevent rainfall and surface runoff from lubricating the interior slide surface, saturating the embankment, and causing future sliding. Sealing the scarp is only a temporary measure and should include contacting the Dam Safety Division.

Slide material in spillway and outlet areas should be removed immediately since its presence reduces the flow capacity. Shallow surface slides can be repaired by removing the slide material and rebuilding the slope to original grade with well compacted pervious material. The cause for any slide should be fully determined before permanent repairs are made to the slope.

Settlement

Settlement occurs both during construction and after the embankment has been completed and placed in service. To a certain degree, this is normal and should be expected. It is usually most pronounced at locations of maximum foundation depth or embankment height. Excessive settlement will reduce the freeboard (the difference in elevation between the water surface and the top of the dam) and may increase the probability of overtopping during a flood.



Excessive Settlement

Any areas of excessive settlement should be restored to original design elevations to reduce the risk of overtopping. A relatively large amount of settlement within a small area could indicate serious problems in the foundation or perhaps in the lower part of the embankment. Settlement accompanied by cracking often precedes failure. When either condition is observed, professional advice should be sought immediately. Settlement can be monitored by measuring the differences in elevation between the problem area and permanent reference monuments located away from the dam. Land surveying instruments are required to make these measurements.

Repair

Soil added to restore an embankment must be properly "keyed" into the base material. This is accomplished by removing the vegetation and all unsuitable material until a good firm base of undisturbed soil is uncovered. Unsuitable materials include wet, soft, porous, organic, and improperly compacted soils. The surface should then be roughened with a disc or similar device to obtain a good bond between "old" and "new" materials. The new soil should be successively placed in thin layers (6 to 8 inches thick) and each layer compacted before adding more material. Filters and drains may also be necessary to correct stability problems.

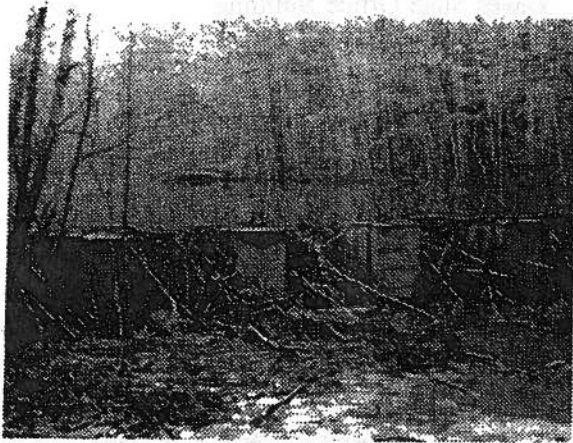
Repair of cracks, slides, and settlement is not considered routine maintenance and must be done under the supervision of a registered engineer who is experienced in the design and repair of dams. A permit must also be obtained from the Water Management Administration's Dam Safety Division.

RODENT CONTROL

Rodents such as the beaver, groundhog, and muskrat are attracted to dams and reservoirs, and can be quite dangerous to the structural integrity and performance of the embankment and spillway. Groundhog and muskrat burrows weaken the embankment and can serve as pathways for seepage. Beavers may plug the spillway and raise the pool level. Rodent control is essential in preserving a well maintained dam.

Beaver

Beavers will try to plug spillways with their cuttings. Routinely removing the cuttings is one way to alleviate the problem. Another successful remedy is the placement of electrically charged wires around the spillway inlet. Trapping beaver may be done by the owner during the appropriate season.



Beaver Dam Blockage in Spillway

Groundhog

Occupied groundhog burrows are easily recognized in the spring due to the groundhog's habit of keeping them "cleaned out." Fresh dirt is generally found at the mouth of active burrows. Half-round mounds, paths leading from the den to nearby fields, and clawed or girdled trees and shrubs also help identify inhabited burrows and dens.

When burrowing into an embankment, groundhogs stay above the phreatic surface (upper surface of seepage or saturation) to stay dry. The burrow is rarely a single tunnel. It is usually forked, with more than one entrance and with several side passages or rooms from 1 to 2 feet long.

Groundhog Control

Control methods should be implemented during early spring when active burrows are easy to find, young groundhogs have not scattered, and there is less likelihood of damage to other wildlife. In later summer, fall, and winter, game animals will scurry into groundhog burrows for brief protection and may even take up permanent nesting during the period of groundhog hibernation.

Groundhogs can be controlled by using fumigants or by shooting. Fumigation is the most practical method of controlling groundhogs. Around buildings or other high fire hazard areas, shooting may be preferable. Groundhogs will be discouraged from inhabiting the embankment if the vegetation cover is properly maintained.

Muskrat

Musk rats can be found wherever there are marshes, swamps, ponds, lakes, and streams having calm or very slowly moving water with vegetation in the water and along the banks. Muskrats make their homes by burrowing into the banks of lakes and streams or by building "houses" of rushes and other plants. Their burrows begin from 6 to 18 inches below the water surface and penetrate the embankment on an upwards slant. At distances up to 15 feet from the entrance, a dry chamber is hollowed out above the water level. Once a muskrat den is occupied, a rise in the water level will cause the muskrat to dig higher to excavate a new dry chamber in the embankment. Damage (and the potential for problems) is compounded where groundhogs or other burrowing animals construct their dens on the opposite side of the embankment.

Muskrat Control

Barriers to prevent burrowing offer the most practical protection to earth structures. A properly constructed riprap and filter layer may discourage burrowing. The filter and riprap should extend at least 3 feet below the water line. As the muskrat attempts to construct a burrow, the sand and gravel of the filter layer cave in and thus discourage den building. Heavy wire fencing laid flat against the slope and extending above and below the waterline can also be effective. Eliminating or reducing aquatic vegetation along the shoreline will discourage muskrat habitation.

Eliminating a Burrow

A method of backfilling a burrow on an embankment is "mudpacking." Lowering of the reservoir pool level may be necessary to accomplish this work. This simple, inexpensive method can be accomplished by placing one or two lengths of metal stove or vent pipe in a vertical position over the entrance of the den. After making sure that the pipe



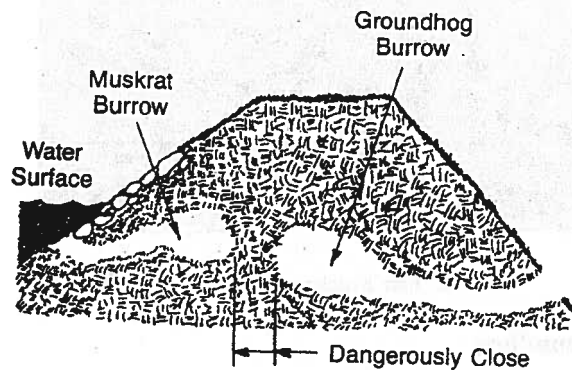
Burrow Under Slab

connection to the den does not leak, the mudpack mixture is then poured into the pipe until the burrow and pipe are filled with the mixture. The pipe is removed and dry earth is tamped into the entrance. The mudpack is made by adding water to a 90 percent earth and 10 percent cement mixture until slurry or thin cement consistency is attained. All entrances should be plugged with well compacted earth, and vegetation reestablished. Dens should be eliminated without delay because damage from just one hole can lead to failure of the dam.

Hunting and Trapping Regulations

Because state regulations change from year to year, hunting and trapping or other methods used to eliminate animals from the dam may have certain restrictions. For more information, the dam owner should contact:

Maryland Department of Natural Resources
Wildlife Administration
Tawes State Office Building
Annapolis, Maryland 21401
(410) 974-3195.



Rodent Burrows

VEGETATED SPILLWAYS

Dams are designed to safely pass a certain "inflow design flood." This flow is in excess of what is considered the normal operating range for the dam. A concrete dam that consists of a single monolithic structure is generally designed to pass the full range of flows anticipated. However, an earthen structure would most certainly be washed away if flow were to pass over top. Therefore, it is impractical, and economically unfeasible, to size the principal spillway to pass the inflow design flood. For this reason an earthen type of dam must allow flood flows to pass around the embankment section through an emergency spillway.

Emergency Spillway

It is extremely important that the dam owner understand the purpose and function of the emergency, or auxiliary, spillway. This area of the dam is often neglected because the owner rarely sees flow in the spillway. It is a common perception of the dam owner that his structure is fail-safe.



Emergency Spillway In Operation

The emergency spillway is designed to pass flood flows around the dam on an infrequent basis. This type of spillway usually consists of a vegetated earthen channel that is precisely dimensioned to convey water without overtopping the dam. A certain amount of erosion and damage to the

spillway is anticipated into the overall design.

A typical spillway section consists of the inlet, control section, and outlet channel.

Spillway Inspection

Vegetated earth spillways are usually the most economical means to provide emergency spillway capacity. Normal flows are carried by the principal spillway, and infrequent large flood flows pass primarily through the emergency spillway. For dams with pipe-conduit spillways, an emergency spillway is almost always required as a back-up in case the pipe becomes plugged.

Maintenance and Repair of Vegetated Earth Spillways

Since the vegetated emergency spillway is used on an infrequent basis, maintenance of the channel should not be a burdensome task. As in the case of the embankment maintenance, there are certain items that need to be attended to that include:

1. **Maintenance of vegetation.** Periodic mowing to prevent trees, brush, and weeds from creating a flow obstruction, particularly at the control section. A poor vegetative cover will usually result in extensive, rapid erosion when the spillway flows, and require more costly repairs. The vegetative cover should be given the same care and maintenance as the embankment of the dam. Reseeding and fertilization is necessary to maintain a vigorous growth of vegetation. Kentucky 31 fescue is an excellent grass for erosion protection (see section on vegetation).
2. **Prompt repair of damage.** Repair of erosion damage, particularly after high flows. Erosion can be expected in the spillway channel during high flows, and can also occur as a result of rainfall and local runoff. The

latter is more of a problem in large spillways, and may require special treatment, such as terraces or drainage channels. Erosion of the side slopes will deposit material in the spillway channel, especially where the side slopes meet the channel bottom. In small spillways, this can significantly reduce the spillway capacity. This condition often occurs immediately after construction, before vegetation becomes established. In these cases, it may be necessary to reshape the channel to provide the flow capacity.

3. **Removal of flow obstructions.** Emergency spillways are often used for purposes other than the passage of flood flows. Among these uses are reservoir access, parking lots, boat ramps, boat storage, pasture and cropland. Permanent structures (buildings, fences, etc.) should not be constructed in these spillways. If fences are absolutely necessary, they should cross the spillway far enough away from its control section (at the highest point in the channel) so they do not interfere with flow. Any change to the dimensions of the spillway channel will alter its capacity to carry flood flows and could cause failure of the dam.



Eroded Spillway



Spillway After Repair

